ASSOCIATION POUR L'ÉTUDE DE LA PALÉONTOLOGIE
ET DE LA STRATIGRAPHIE HOUILLÈRES

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Marker horizons in the Namurian of Britain, Ireland, Belgium and Western Germany

BY

FRANK HODSON
University of Reading

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2. — CH. DELEERS et A. PASTIELS, *Étude biométrique des* Anthraconauta *du Houiller de la Belgique* (Première partie), in-4° 1947

3. — CH. ANCION, J. DAUTREBANDE, W. VAN LECKWYCK, A. PASTIELS et Y. WILLIÈRE, *Étude géologique du Bassin houiller de Liège. La concession de Marihaye*, in-4° 1948

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5. — H. CHAUDOIR, M. SNEL, A. PASTIELS et Y. WILLIÈRE, *Étude du Gisement houiller de la Campine. Contribution à l'Étude stratigraphique et paléontologique du Westphalien B supérieur : La zone d'Eikenberg*, in-4° 1950

6. — H. CHAUDOIR, CH. ANCION, A. PASTIELS et Y. WILLIÈRE, *Étude géologique du Bassin houiller de Liège. Le Massif de Herve. Région orientale*, in-4° 1950

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CONTENTS

MARKER HORIZONS IN THE NAMURIAN OF BRITAIN, IRELAND, BELGIUM AND WESTERN GERMANY

INTRODUCTION.

Since **1924**, the succession of goniatite faunas worked out for England by W. S. Bisat and for Germany by H. Schmidt, has revolutionised the stratigraphy of the Carboniferous and especially that of the Namurian or lowest part of the Upper Carboniferous. The scheme of zones and subzones elaborated on the early studies of Bisat and Schmidt provide a delicate chronological framework within which to date mid-Carboniferous events.

Marine incursions became less and less frequent as the Carboniferous era progressed until they finally ceased in the upper Westphalian. Before their final cessation, the Westphalian marine bands are relatively widely spaced. They are remarkably constant over very wide areas and have proved invaluable marker horizons for correlation with absolute precision enabling virtually synchronous palaegeographical events to be recognised over wide areas.

In the Namurian, and especially in its lower portions, marine beds are much more frequent and the mere recognition of such a bed has not the same stratigraphical significance as in the Westphalian. In the Namurian, therefore, it has not been usual to correlate by means of single, thin, distinctive, marine beds. The goniatite faunas of these beds may be regarded as samples of an evolving plexus of descent on a single time-plane and closely spaced samples yield successive faunas which are closely allied. So long as fine discrimination between these allied forms remains unaccomplished, no further refinement of the stratigraphy is possible since there must be the same order of detail in both the palaeontology and the stratigraphy. In England, Bisat has brought the conception of a goniatite species within finer and finer limits and this has resulted in correlation within equally smaller limits of uncertainty. The success of his methods points the way to future endeavour.

On the Continent, however, the coarser correlations, based on his earlier studies, are still in vogue and this paper attempts to illustrate the potentialities of fine specific discrimination in goniatites for absolute correlation of beds in a part of the Namurian from the west of Ireland to the Sauerland of Western Germany.

STRATIGRAPHICAL PALAEONTOLOGY.

The faunal divisions of the rocks of the *Homoceras* and Lower *Reticuloceras* stages due to Bisat and Hudson (1943) and Hudson (1945) are as follows :

	Zones	Subzones
Kinderscoutian Stage Lower *Reticuloceras* Age (R_1)	*R. reticulatum* (R_{1c})	*R. coreticulatum* *R. reticulatum*
	R. eoreticulatum (R_{1b})	*R. nodosum* *R. dubium*
	R. inconstans (R_{1a})	*R. todmordenense* *R. circumplicatile*
Sabdenian Stage *Homoceras* Age (H)	*H. eostriolatum* (H_b)	*H. eostriolatum* *H. undulatum* *H. smithi*
	H. beyrichianum (H_a)	*H. beyrichianum* *H. subglobosum*

In this paper, the scheme depicted above is modified by the subdivision of the Sabdenian Stage into two stages for which new names are proposed. It is proposed that the subzones be elevated into the status of zones and that within these zones certain faunal bands should be recognised for more precise stratigraphical correlation. It might here be mentioned that the present subzones of the Kinderscoutian were originally erected as zones (Bisat and Hudson, 1943, p. 386) and later relegated to subzones (Hudson, 1945, p. 5). Following

these proposals, the strata deposited during the *Homoceras* Age will be subdivided as follows :

	Zones	Faunal Bands
ALPORTIAN STAGE Upper *Homoceras* Age (H_2)	*H. eostriolatum* (H_{2c})	*Ht. prereticulatus* *H. eostriolatum*
	H. undulatum (H_{2b})	*H. undulatum*
	H. smithi (H_{2a})	*H. smithi* and *Hd. proteum*
CHOKIERIAN STAGE Lower *Homoceras* Age (H_1)	*H. beyrichianum* (H_{1b}) *H. subglobosum* (H_{1a})	— —

The base of the Chokierian Stage is taken as the base of the first faunal band containing *Homoceras*. Thus the faunal band with *Eumorphoceras bisulcatum*, *Nuculoceras nuculum*, *Cravenoceras darwenense* and *Cravenoceratoides* spp. must be regarded as E_2 although some authors (BISAT, 1928, Pl. VI; STEPHENS and others, 1942, p. 350) have considered it as of *Homoceras* Age.

The base of the Alportian is the base of the *Homoceras smithi*-*Hudsonoceras proteum* faunal band and the top of the Stage is the base of the *Homoceras magistrorum* sp. nov. faunal band (see p. 9).

In Belgium, the following subdivisions are in current usage :

	Reticuloceras bilingue.	Assise d'Andenne
Zone of Sippenaken supérieure :		
	Reticuloceras reticulatum.	
Zone of Sippenaken moyenne :		
	Homoceratoides prereticulatus.	
Zone of Sippenaken inferieure :		
	Dry Veine coal seam.	————
Zone of Spy :		Assise de Chokier
	Homoceras subglobosum.	
Zone of Malonne :		
	Eumorphoceras bisulcatum s.s.	
Zone of Bioul :		
	Cravenoceras leion.	

It will be seen that the junction between the Assise de Chokier and the Assise d'Andenne is taken at the first coal seam as one ascends the Belgian Namurian, that is to say a lithological character is used to define the junction. The boundary between the proposed Chokierian and Alportian (i.e. the *Homoceras smithi - Hudsonoceras proteum* band) has not with certainty been found in Belgium but it may occur in Bed 52 of the Java Gallery, in which case the junction would lie above the Grande Veine de Marsinne and below the Petite Veine de Marsinne or about 23 m. above the Dry Veine.

The top of the Alportian, as here defined, lies about 3 m. above the junction of the zone of Sippenaken inférieure and Sippenaken moyenne (*Homoceratoides prereticulatus* band).

Marker horizons known in England and Eire within the stratigraphical range from the base of the *H. smithi* zone, at the base of the Alportian, to the *R. todmordenense* zone of the Kinderscoutian, are listed below with notes on their distribution in so far as it has been ascertained at present.

FAUNAL BANDS IN THE H_2 AND BASAL R_1 STAGES.

1. — The **Hudsonoceras proteum-Homoceras smithi** faunal band.

This band has been recorded from the North of England and from the West of Ireland and for long has been recognised as a very reliable marker horizon being restricted to a few centimetres of shale or represented by a single line of bullions. There has been some confusion in the recognition of the species *Hudsonoceras proteum* and previous records from the Continent have been misidentifications of *Hudsonoceras ornatum* and certain undescribed species of the genus which occur at higher levels in the R_1 and R_2 zones so that no reliable record of the species outside England and Eire is yet to hand.

2. — The **Homoceras undulatum** faunal band.

This is known from the West and East of Ireland and in England and Wales, from Lancashire, Yorkshire, Derbyshire and the Gower Peninsula. Where the beds are sufficiently explored it always succeeds the *Hd. proteum - H. smithi* faunal band. As yet, it remains unrecorded from the Continent. The index species resembles certain forms of *Homoceras* from the *H. subglobosum* zone (H_{1a}) and also certain forms of the genus *Cravenoceratoides* from the Upper *Eumorphoceras* zone (E_2). Moreover, unlike the previous band, the *H. undulatum* band is relatively thick, being almost 3 m. thick in some places, with specimens distributed throughout that thickness although usually more abun-

dant on two thin horizons. It seems possible therefore that in more expanded successions a considerable thickness of beds may be spanned by the range of this species so that perhaps this band will not have the same value as some of the others here described.

3. — The **Homoceras eostriolatum** faunal band.

The band is best known at Roughlee in Lancashire where it is rendered conspicuous by the occurrence of bullions in the bed. It is recorded also from Alport and the Gower Peninsula.

4. — The **Homoceratoides prereticulatus** faunal band.

This is widespread in England and Ireland and is also found in the Spy and Java galleries in Belgium. There is some uncertainty regarding the index species of the bed which is by far the most prevalent form occurring in it. The associated goniatites are rare specimens of *Homoceras* aff. *eostriolatum* and *Dimorphoceras* sp. The holotype of *Ht. prereticulatus* was found in a loose bullion of which the precise horizon was uncertain. It is known that forms with the general morphological aspect of this species range upwards from the faunal band we are now considering into the lower levels of the R_1 zone so that the type material might have come from anywhere within this interval. Differences are to be seen between individual specimens from this range of beds but it is yet to be demonstrated that stratigraphically different forms differ more than extreme variants on one particular level and until that is accomplished there would appear to be no point in refusing to identify all the specimens, having near affinity to the holotype, as *Ht. prereticulatus*. If a narrower concept of the species is taken, as has been the case recently, the common form occurring on this faunal band might be called *Ht.* aff. *prereticulatus*.

5. — The **Homoceras magistrorum** sp. nov. faunal band.

This marine band contains the species *Reticuloceras compressum*, *Homoceras magistrorum* sp. nov., *H. henkei* and *Dimorphoceras looneyi*. One of the purposes of this paper is to draw attention to the usefulness of this band, which was first demonstrated to mark the base of the R_1 zone in western Ireland, for absolute correlation (Hodson, 1954 *a*). It has since been found in eastern Ireland, precisely located in Lancashire and the Gower Peninsula and identified in the Java Gallery in Belgium and at Neheim in Westphalia. It thus promises to be an important horizon for correlation in the Namurian. The thickness of the

beds between this band and the next has been ascertained in a number of widely separated localities and it is thus possible to compare the rate of sedimentation in these scattered places at the commencement of the Lower *Reticuloceras* Age.

6. — The **Reticuloceras circumplicatile-Homoceratoides varicatus** faunal band.

This also has been traced over the same area as the former and is always seen to succeed the *Homoceras magistrorum* band wherever exploration has been sufficiently thorough for its detection. The species *R. circumplicatile* resembles *R. paucicrenulatum* from the top of the *R. todmordenense* subzone but the presence of *Homoceratoides varicatus* renders the present faunal horizon distinctive.

7. — The Upper **Reticuloceras circumplicatile** faunal band.

At one locality in the West of Ireland there appears to succeed the *R. circumplicatile - Ht. varicatus* band a further bed containing the former species but without the latter (Hodson, 1954*a*, p. 270). This has not been found elsewhere and the original exposure will have to be checked to determine whether the actual relationship is that which has been described.

8. — The **Reticuloceras umbilicatum** faunal band.

Above the *R. circumplicatile - Ht. varicatus* band at Roughlee in Lancashire, there is a thin shale which contains *R. umbilicatum*. This part of the succession is insufficiently explored elsewhere to claim that this bed is present elsewhere in the same stratigraphical relationship.

9. — The **Reticuloceras pulchellum** faunal band.

Again at Roughlee, where these particular beds are best known, this band succeeds the *R. umbilicatum* band being confined to a thin shale bed. It has not been separated elsewhere as yet although the type material came from western Eire in County Limerick. The type locality has not yet been rediscovered.

10. — The **Reticuloceras todmordenense** faunal band.

This bed is known from Lancashire and Yorkshire in England and has been correlated with bands containing *R. subreticulatum* in County Clare and County Limerick in Eire. These species are very closely allied. In addition to *R. todmordenense* and *R. subreticulatum* there are rare specimens of *H.* aff. *henkei*. Excellent material has been collected from bullions both in England and Eire.

11. — The **Reticuloceras paucicrenulatum** faunal band.

This bed is known in Lancashire and Yorkshire where it is separated from the previous band by a few metres of shale. In County Clare and County Limerick the interval between the two beds seems to be subject to enormous variation.

The higher beds of the Lower *Reticuloceras* Stage are not known in sufficient detail to warrant a definite statement as to the number and succession of other faunal bands.

DESCRIPTION OF LOCAL SUCCESSIONS.

The correlation between the sections discussed below is shown in Plate II.

NORTH-WEST COUNTY CLARE, EIRE.

In North-West County Clare, the Carboniferous beds are nearly horizontal, apparently protected from tectonic disturbance by the southern extension of the rigid Galway massif under the Carboniferous of the area. The beds of Upper *Homoceras* and Lower *Reticuloceras* Age contain a succession of faunal horizons of which the vertical superposition is unambiguously demonstrated in many localities. The fauna is abundant and very well preserved. The area, which was described by the author in 1954, can be taken as a standard for that portion of the Carboniferous lying near to the *Homoceras*/*Reticuloceras* stage junction. The succession is condensed and the Alportian is only 0,90 m. thick. The beds rest with a great non-sequence on the Carboniferous Limestone and from the River Shannon northwards to Galway Bay successive faunal bands are overlapped. At the southern end of this line is Foynes Island in the River Shannon which was described by the author (Hodson, 1954 *b*). Since that date, further collecting has resulted in some elaboration of the successions originally described. A summary of the successions is given below :

Faunal band.	Index species.
J	*Reticuloceras paucicrenulatum* [1].
Interval	4,60 m. approximately.
I	*Reticuloceras subreticulatum*, *Homoceras henkei*, *Dimorphoceras looneyi*.
Interval	4,60 m. approximately.
H	*Reticuloceras circumplicatile*, *Homoceras henkei*.
Interval	1,30 m. approximately.

(1) The authors of the various species of goniatites mentioned in this paper are :
Cravenoceras : *darwenense* Moore, *leion* Bisat.
Dimorphoceras : *looneyi* (Phillips), *moorei* Hodson.
Eumorphoceras : *bisulcatum* (Girty).

G	*Reticuloceras circumplicatile*, *Homoceras henkei*, *Homoceratoides varicatus.*
Interval	0,30 m.
F	*Reticuloceras compressum*, *Homoceras henkei*, *Homoceras magistrorum*, *Dimorphoceras looneyi.*
Interval	0,30 m.
E	*Homoceratoides prereticulatus*, *Homoceras* aff. *eostriolatum*, *Dimorphoceras* sp.
Interval	0,30 m.
D	*Homoceras undulatum*, *Dimorphoceras* sp.
Interval	0,30 m.
C	*Hudsonoceras proteum*, *Homoceras smithi*, *Dimorphoceras moorei.*
Interval	1,20 m.
B	*Homoceras beyrichianum.*
Interval	2,10 m.
A	*Homoceras beyrichianum*, *Homoceras* aff. *subglobosum.*
Interval	0-4,20 m.
	Carboniferous Limestone.

To the North, the basal faunal band « A » is overstepped and faunal band « B » occurs about 1,20 m. above the Carboniferous Limestone. No evidence as to the age of the uppermost beds of the latter in the goniatite zonal scheme has been found but there is evidently a considerable non-sequence between it and the basal shales above although there is no marked sign of disconformity between the two.

FOYNES ISLAND, COUNTY LIMERICK, EIRE.

Foynes Island lies near the southern bank of the River Shannon and the Namurian succession of the island was described by the author (Hodson, 1954 *b*), since which time further details have become available and are incorporated in the summary of the succession given below. A continuous section of some 92 m. can be measured which includes the whole of the *Homoceras* stages with portions of the Upper *Eumorphoceras* stage below and the Lower *Reticuloceras* stage above. The H_1 stage is about 19 m. thick and the H_2 stage about

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Homoceras : *beyrichianum* (de Kon. emend. Haug), *eostriolatum* Bisat, *henkei* Schmidt, *smithi* (Brown), *subglobosum* Bisat, *undulatum* (Brown).

Homoceratoides : *divaricatus* (Hind), *prereticulatus* Bisat, *varicatus* Schmidt.

Hudsonoceras : *ornatum* (Foord and Crick), *proteum* (Brown).

Nuculoceras : *nuculum* Bisat.

Reticuloceras : *bilingue* (Salter), *circumplicatile* (Foord), *compressum* Bisat and Hudson, *coreticulatum* Bisat and Hudson, *dubium* Bisat and Hudson, *inconstans* (Phillips), *eoreticulatum* Bisat, *nodosum* Bisat and Hudson, *pulchellum* (Foord), *subreticulatum* (Foord), *recticulatum* (Phillips), *todmordenense* Bisat and Hudson, *umbilicatum* Bisat and Hudson.

3,50 m. thick but unfortunately the exact dividing line (the faunal band with *Homoceras magistrorum*) has not yet been detected although further search ought to reveal it.

	Metres.
Sandstones.	
Shales and sandstones ...	4,35
Bullions with *Reticuloceras subreticulatum* and *Homoceratoides divaricatus* ...	0,10
Interval ...	4,60
Bullions with *Reticuloceras circumplicatile* ...	0,10
Interval ...	0,90
Bullions with *Homoceratoides prereticulatus* ...	0,15
Interval ...	3,00
Bullions with *Hudsonoceras proteum* and *Homoceras smithi* ...	0,10
Interval ...	9,00
Shales with *Homoceras beyrichianum* ...	0,30
Interval ...	9,50
Shales with *Homoceras subglobosum* ...	0,15
Interval ...	2,35
Shales with *Nuculoceras nuculum* and *Eumorphoceras bisulcatum* ...	0,15

EASTERN IRELAND.

Dr. E. Nevill of Trinity College Dublin, who is investigating the Namurian of County Meath and County Leinster, has permitted me to examine some of his collections from which it is evident that the *Homoceras undulatum*, *Homoceras magistrorum* and the *Reticuloceras circumplicatile* beds (i.e. faunal bands « D », « F » and « G » of north-west County Clare) are present in eastern Ireland.

SAMLESBURY BOTTOMS, NEAR BLACKBURN, LANCASHIRE, ENGLAND.

This is an excellent section which displays the full thickness of the *Homoceras* stages (about 65 m. thick) and a part of the Lower *Reticuloceras* stage. The Chokierian is 59 m. thick and the Alportian 6 m. It was first described by Moore (1930) who has systematically collected from the section over many years and supplied the materials upon which Bisat and Hudson (1943, pp. 397-398) based their account. This latter description includes in some of the stratal groups bands which would best be listed separately but further work is necessary before each thin fossiliferous horizon can be individually recognised. However, the summarised succession given below separates, so far as is possible

at present, the faunal bands which have been detected in that part of the section relevant to the present discussion.

	Metres.
Shales with *Reticuloceras paucicrenulatum*.	
Interval	1,50
Shales with fauna including *Reticuloceras circumplicatile*, *R. umbilicatum*, *R. pulchellum*, *Homoceratoides varicatus*, *Ht. mutabilis*, *Homoceras henkei*	3,00
Interval	1,05
Bullions with *Homoceras magistrorum*, *H. henkei*	0,15
Interval	0,90
Bullions with *Homoceratoides prereticulatus*	0,15
Interval	2,25
Shale with *Homoceras undulatum*	0,15
Interval	1,35
Shale with *Homoceras undulatum*	0,15
Interval	1,05
Shale with *Homoceras smithi* and *Hudsonoceras proteum*	0,15

ROUGHLEE, LANCASHIRE, ENGLAND.

The first measured section of this important exposure which straddles the boundary between the Upper *Homoceras* and *Reticuloceras* stages was published by Bisat and Hudson (1943, p. 399). The section is exposed sporadically in the banks of Pendle Water, near the hamlet of Roughlee, near Nelson. Collecting has been done here by Mr. E. W. J. Moore (since 1930), the author (since 1943), Dr. W. H. C. Ramsbottom and the Geological Survey (prior to 1927 and more recently during the revision of Sheet 68). The following amplification of the published account is due to Mr. E. W. J. Moore and the author who had the valuable assistance of Dr. Ramsbottom. Because of landslipping and the concealment of beds by river detritus, the condition of the section varies greatly from time to time and it is only by continual visits that the succession has gradually been elucidated.

		Metres.
R_1	Bullions with *Reticuloceras paucicrenulatum*	0,15
	Interval	0,90
	Bullions with *Reticuloceras subreticulatum* and *R. todmordenense* ...	0,15
	Interval	1,50
	Shale with *Reticuloceras pulchellum*	0,30
	Interval	0,90
	Shale with *Reticuloceras umbilicatum*	0,30

		Metres.
	Interval ... ... approximately	1,50
	Bullions with *Reticuloceras circumplicatile*	0,15
	Interval ... ... approximately	1,35
	Bullion with *Homoceras magistrorum* and *H. henkei*	0,15
H_2	Interval	2,55
	Shale with *Homoceratoides prereticulatus*	0,45
	Interval	2,10
	Shale and bullions with *Homoceras eostriolatum*	0,60
	Interval	1,20
	Shale with *Homoceras undulatum* on various levels	3,60
	Interval	0,90
	Shale with bullions containing *Homoceras smithi* and *Hudsonoceras proteum*	0,15

The Alportian is thus 11,55 m. thick.

BARLAND COMMON, GOWER, SOUTH WALES.

In the collections of the Geological Survey of Great Britain, there is a series of specimens collected from a stream section on Barland Common by Mr. J. V. Stephens. I am obliged to Mr. Stephens and to the Director of the Geological Survey for permitting me to publish the following section of the beds and their fossil contents.

	Metres.
Bed 14. *Reticuloceras circumplicatile* group.	
Interval	6,00
Bed 13. *Homoceras magistrorum* and *H. henkei.*	
Interval	1,50
Bed 12. *Homoceras eostriolatum* group.	
Interval	4,50
Bed 11. *Homoceras undulatum.*	

This is the only section in Great Britain, south of the ancient Midland Barrier of St George's Land, yet available for comparison with beds of the same age to the north of the Barrier. This comparison shows that these beds are thicker to the south and this expansion is greater in the upper part of the section.

ALPORT BOREHOLE, DERBYSHIRE, ENGLAND.

In the Alport borehole (HUDSON and COTTON, 1943) 29 m. of beds of *Homoceras* Age were encountered, of which 9 m. are to be assigned to the Alportian and 20 m. to the Chokierian. The following is that portion of the borehole which passed through the Alportian.

Depth.	Goniatites.
108-110 feet.	*Reticuloceras circumplicatile* and *Homoceras henkei*.
110-112 feet.	*Homoceratoides prereticulatus*.
112-116 feet.	*Homoceras* sp.
116-127 feet.	*Homoceras eostriolatum*.
127-139 feet.	*Homoceras* cf. *undulatum*, with *Hudsonoceras proteum* and *Homoceras smithi* at base.

The *Homoceras magistrorum* band was not recorded by these workers but might be expected to have occured at 110 feet down the borehole.

JAVA GALLERY, BELGIUM.

The best section straddling the junction of the Upper *Homoceras* and Lower *Reticuloceras* stages is that of the Java Gallery situated 6 km. from Huy. The section is displayed in the walls of a mine gallery which is now water-logged. It was fully described by ANCION and VAN LECKWIJCK (1947) and the fossils determined by DEMANET. The collections are housed at the Association for the Study of the Coal Measures and were placed at the author's disposal for re-examination in the light of the detailed succession made out for the *Homoceras* and Lower *Reticuloceras* stages in England and Ireland.

As a result of this re-examination, the exact correlation of certain of the lower beds can be made with the standard succession established for the West of Ireland. The following is a summary of the relevant part of the succession :

	Metres.
Bed 71	0,28, equivalent to Irish bed « G ».
Interval	4,25.
Bed 67	1,20, equivalent to Irish bed « F ».
Interval	1,50.
Bed 66	0,95, equivalent to Irish bed « E ».
Interval	15,00.
Bed 52	0,10.

The best fossiliferous bed is No. 67 which contains a thin limestone (No. 67*i*) in which decayed solid goniatites occur. In the condition in which they are

collected, they are not very promising for exact identification but, when the powdery limestone now representing the fossils is gently removed, excellent external moulds are available which preserve all the details of the fine shell ornament. Casts made from these moulds permit the goniatites to be identified. The goniatite fauna comprises *Homoceras magistrorum* sp. nov., *H. henkei* and *Dimorphoceras looneyi*. It is thus the equivalent of the Irish bed « F » and marks the base of the Lower *Reticuloceras* stage.

Bed 67 lies at an estimated distance of 1,50 m. above Bed 66 but the strata between the two are concealed in the walls of the gallery. Bed 66 *c* contains *Homoceratoides prereticulatus* Bisat and is the Belgian equivalent of the Irish bed « E ». The fossils are flattened in shale and include, in addition to the above, a finely striate species of *Homoceras* which occurs in the same bed elsewhere and is referred to as *H.* aff. *eostriolatum*.

Lying 4,25 m. above 67 is Bed 71 which is a shale containing impressions of *R. circumplicatile* and *Homoceratoides varicatus* and is thus the equivalent of the Irish bed « G ». Whereas the interval which spans beds « E » to « G » in the West of Ireland is less than 1 m. the interval is represented by about 8 m. in the Java Gallery.

In the Java Gallery, some of the beds just described are repeated by faulting and Bed 85, which contains *Homoceratoides prereticulatus* at the base (Bed 85*a*) and a black limestone with goniatites which cannot be extracted at the top (85*e*), is the representative of Beds 66 and 67. The equivalent of Bed 71, which might have been expected to have occurred between Beds 87 and 88, is probably concealed by the small strike fault which separates them.

15 m. below Bed 66 lies Bed 52 which might have been expected to lie near the level of the *Hudsonoceras proteum* and *Homoceras smithi* bed « C » of the Irish succession. The goniatites in Bed 52 are very poorly preserved, mere ghosts, but include forms which are fairly heavily ribbed as well as finely striate forms with an appreciable lingua. The latter might be flattened internal moulds of *Hudsonoceras proteum* since they show a wrinkling of the flanks in the vicinity of the lingua which is exhibited by internal moulds of *Hudsonoceras proteum*. Very doubtful traces of spirals can perhaps be discerned and it is known that the spiral ornament of *Hudsonoceras proteum* is faint on the internal mould. The horizon is very tentatively correlated with the Irish bed « C ».

HORDIN GALLERY, SPY, BELGIUM.

The section of this gallery was described by Demanet and Biot in 1951. Bed 53 contains *Homoceratoides prereticulatus* and *Homoceras* cf. *eostriolatum* and is the equivalent of the Irish faunal band « E » and Bed 66 of the Java Gallery. The Veine du Calvaire coal seam (Bed 30) would appear, from its stratigraphical position, to be the equivalent of the Grande Veine de Marsinne, of the Java

Gallery and, if this is the case, then the important marker horizon with *Hudsonoceras proteum* and *Homoceras smithi* (i.e. the Bed 52 of the Java Gallery) would occur about midway in the 30 m. of strata which separate the Hordin Beds 30 and 53, and is possibly near the marine Bed No. 38 *b*.

NEHEIM, WESTERN GERMANY.

Representatives of the marker horizons here discussed have been found at Neheim in Westphalia.

The Emde brickworks quarry at Neheim (text fig. 1) has yielded goniatites which were described by SCHMIDT (1933). Until now, however, no stratigraphical details have been published of this important section. The quarry is situated on the East side of the road between the railway station and the town centre and has been worked on two levels but only the lower of these is readily accessible for detailed study. Altogether some 20 m. of beds are exposed affected by a complicated, faulted synclinal fold which has an East-West axis pitching gently to the East. Three fossiliferous bands are present and their position together with the tectonic structure of the beds is shown in text figure 1, based on field sketches and measurement made by the author and W. P. VAN LECKWIJCK. A summary of the geological succession is given below :

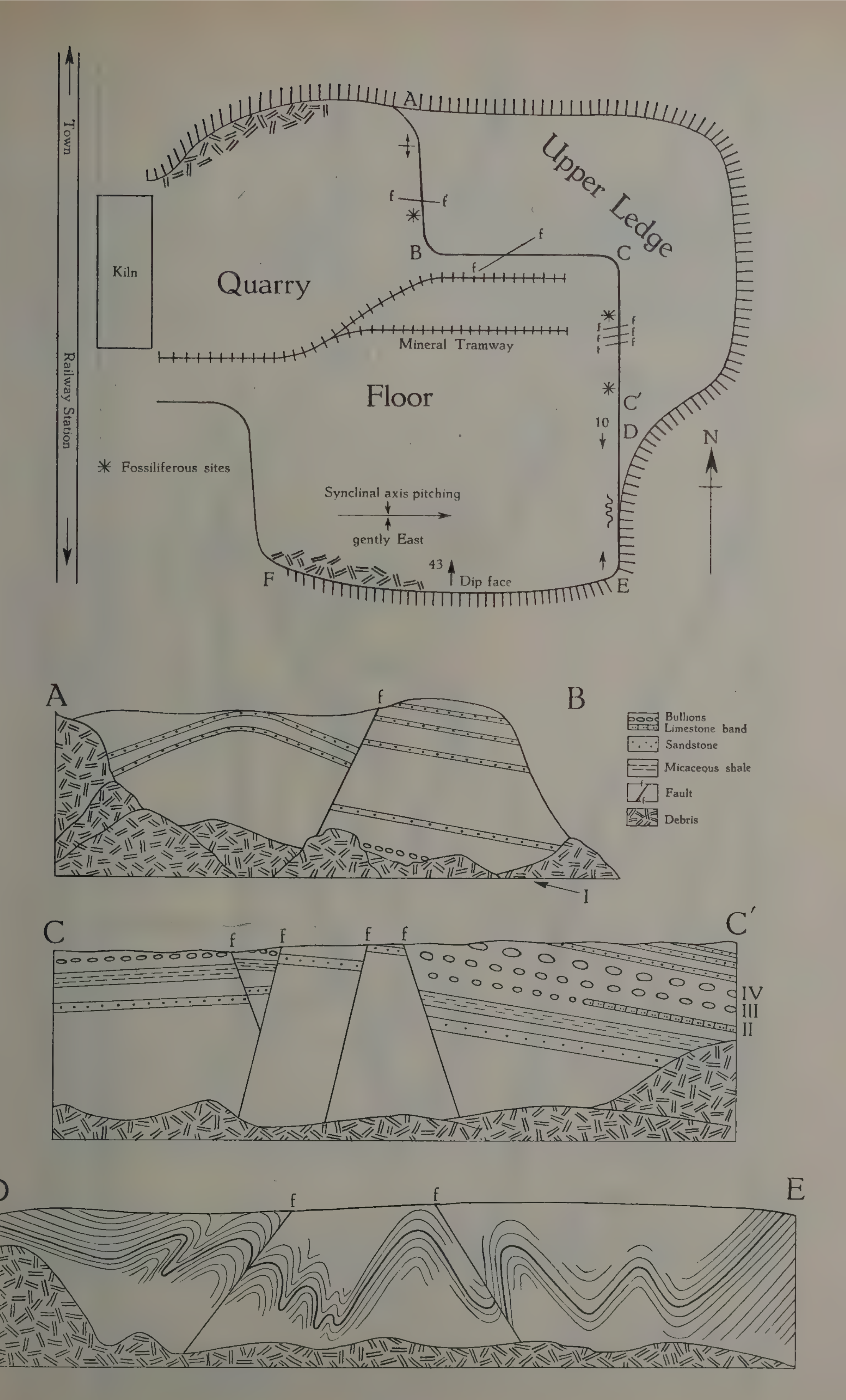
		Metres.
IV. —	Large, apparently unfossiliferous nodules	0,20
	Interval	0,35
III. —	Bullions with *R. circumplicatile* and *Ht. varicatus*	0,12
	Interval	0,45
II. —	Small bullions, passing into a thin limestone band, containing same fauna as Bed III	0,05
	Interval	10,50
I. —	Bullions with *H. magistrorum* and *H. henkei*	0,10
	Total	11,77

Bed I is clearly the equivalent of the Irish bed « F » and the Bed 67 of the Java Gallery. Beds II and III together represent the Irish bed « G » and Bed 71 of Java. It is interesting to find it in two leaves in the Neheim section but no difference could be detected in the fauna of the two beds.



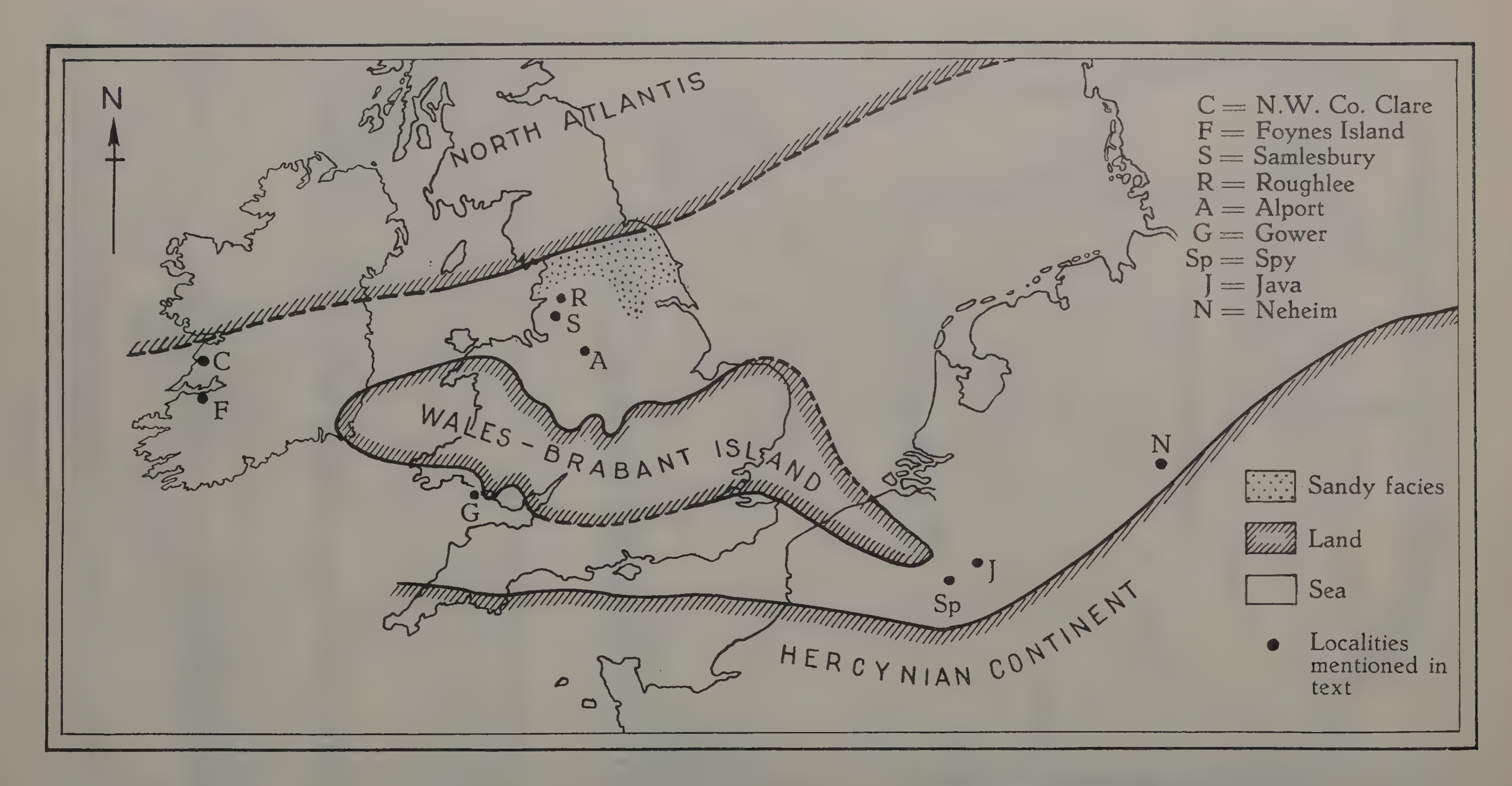
EXPLANATION OF TEXT FIG. 1.

Geological relations of the beds exposed in the Emde Brickworks Quarry, Neheim, Westphalia, with sketch sections between the points lettered on the diagrammatic plan.



Town
Railway Station
Kiln
Quarry
Floor
Upper Ledge
Mineral Tramway
A
B
C
C′
D
E
F
f
10
43
Dip face
N
Fossiliferous sites
Synclinal axis pitching
gently East
Bullions
Limestone band
Sandstone
Micaceous shale
Fault
Debris
I
IV
III
II

TEXT FIG. 1.



TEXT FIG. 2. — Palaeogeographical map of North-West Europe during the *Homoceras* Age with the location of places mentioned in the text. Based on WILLS, 1951 and TROTTER, 1952.

The easterly thickening of the beds is clearly brought out when we consider that beds « F » and « G » are separated by about 0,30 m. in Western Ireland, by 1,30 m. in Lancashire and 4,25 m. in the Java Gallery whilst at Neheim they are separated by 10,50 m. (see Plate I). Moreover, the identity of the faunal horizons detected in Western Ireland with those of Western Germany and their continuity over 1.000 km. testifies to the uniformity of palaeogeographical conditions which prevailed, at least over Western Europe, during these times (text fig. 2).

TABLE I. — **Table of Comparative Thicknesses of Beds belonging to selected Divisions of the Namurian of Western Europe.**

Locality	Chokierian m.	Alportian m.	Basal R_1 (*) m.
N. W. County Clare ... ... , ...	3,30 +	0,90	0,30
Foynes Island	19,00	3,50	0,50 (?)
Alport	29,00	0,00	?
Roughlee	—	11,55	1,05 app.
Samlesbury	59,00	6,00	1,35 app.
Barland Common, Gower, Wales	—	—	6,00
Java Gallery	45,50 (**)	18,75	4,25
Neheim	—	—	10,50

PALAEONTOLOGY.

Homoceras magistrorum sp. nov. — Plate C, fig. 1, Pl. D, figs. 1-6, text figs. 3 *a-e*.

Homoceras sp. nov. A., BISAT and HUDSON, 1943, p. 404.
Homoceras sp. nov. A., HODSON, 1954 *a*, p. 265.

Diagnosis. — *Homoceras* with forwardly bent short plications at umbilical edge degenerating into striae; persistent constrictions on internal mould and wide lateral lobe in septal suture.

Holotype : G.S.L. 86909, Plate C, fig. 1.

Paratypes : G.S.L. 86911 - 3, 86915.

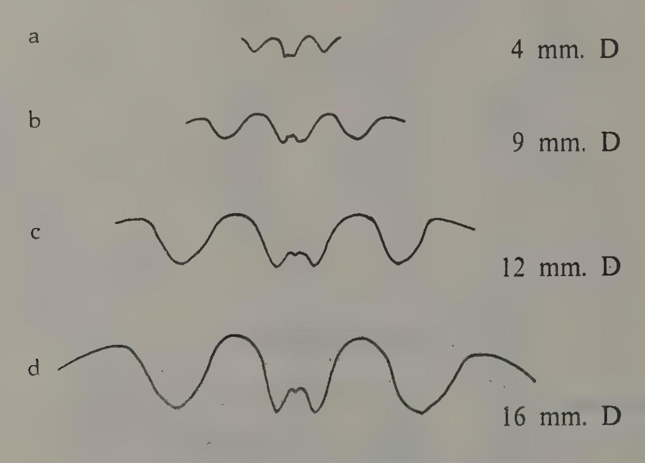
(*) Spacing between *H. magistrorum* and *R. circumplicatile* faunal bands.

(**) Although no definite E_2 goniatites have previously been reported from the Java Gallery, during a revision of the material from Bed 11, *Cravenoceratoides* sp. was seen and the base of the Chokierian has therefore been drawn at the base of Bed 12.

Dimensions.	Diameter.	Whorl width.	Umbilicus.
—	—	—	—
G.S.L. 86909	10,2 mm.	6,9 mm.	3,0 mm.
G.S.L. 86912	13,2 mm.	8,8 mm.	4,7 mm.
G.S.L. 86913	15,7 mm.	10,4 mm.	4,5 mm.
G.S.L. 86911	19,2 mm.	10,2 mm.	3,5 mm.
G.S.L. 86915	23,0 mm.	13,0 mm.	4,1 mm.

Description. — The shell form is relatively involute with flattish flanks converging to a well rounded venter (text fig. 3*e*). The greatest width is at the umbilical edge. Both the ratio of umbilical width to shell-diameter and whorl-width to diameter are somewhat variable in different specimens even at the same shell-diameter. Some forms (i.e. G.S.L. **86912-3**, Plate D, figs. **2-4**) are more globose and with a wider umbilicus than the typical form (text fig. 3*f*).

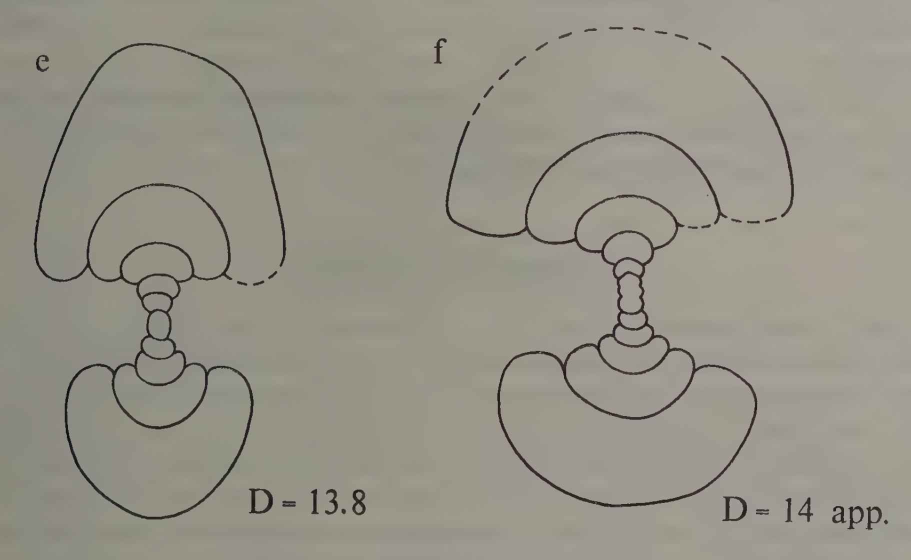
The umbilical edge is typically rounded with sloping walls on the inner area but the more globose forms, referred to above, have a more angular umbilical edge.



TEXT FIG. 3. — *Homoceras magistrorum* sp. nov.
a-d : Ontogenetic development of suture-line. ×4.

The species displays its most typical characteristics in adolescence (i.e. between shell-diameters of 10-18 mm.). During this stage of growth there are short, curved, forwardly directed plications on the umbilical edge. These plications are thickest in the middle and degenerate both on the inner area and on the flanks. Between the umbilical edge and the distal (ventral) end of each plication there usually arise from the latter three striae which make an angle with the general direction of the plication. There are also, interpolated with these striae, certain others which are not connected to the plications and

pass over the umbilical rim and into the inner area without making any noticeable feature on the rim. From the point of origin, each striation passes almost radially up the flanks with a very slight flexuous course involving a suspicion of a backward bow on the flanks and an equally subdued forward bow or lingua at the ventro-lateral shoulder. They then pass over the venter with a marked hyponomic sinus which appears early. A specimen of 6 mm. shell-diameter showed a slight hyponomic sinus and in another it reached a depth of 3 mm. at **24** mm. shell-diameter. At **12** mm. shell-diameter the striae were spaced at an average of 3 ½ per millimetre. With increasing shell-diameter the plications become feeble and finally disappear so that the umbilical edge becomes plain. The lingua and the hyponomic sinus at the same time become more marked.



Text fig. 3. — *Homoceras magistrorum* sp. nov.
The shell-diameters (D) in millimetres.

On the internal mould, the ornament is very subdued but the plications can usually be detected. In this state of preservation, however, the most noticeable feature is the presence of persistent constrictions due to periodic internal thickenings of the test. These numbered 5 on the last whorl of a specimen of maximum shell-diameter of 25 mm. (Plate D, fig. 1). They may, however, vary in number from 4 to 6 and are often of variable depth. On certain rare specimens they are much shallower than usual.

The development of the septal suture is shown in text figure 3, *a-d*. The median saddle remains low, never exceeding one third of the depth of the ventral (external) lobe which is wide and with divergent sides. In contrast to *Homoceras henkei*, which accompanies *Homoceras magistrorum* in the same faunal band, the latter has a very wide lateral lobe.

Remarks : *Homoceras magistrorum* is a very useful index fossil which, so far as is known, has never been reliably recorded except in the particular thin bed here referred to as the *Homoceras magistrorum* faunal band. There it accompanies *Homoceras henkei* and *Reticuloceras compressum* so that it must be referred to the Lower *Reticuloceras* Stage and indeed marks the base of that stratal division.

The internal mould resembles Beyrich's figure of *Homoceras diadema* from Chokier (cf. Pl. D, fig. 1, with Beyrich, 1837, Pl. 2, figs. 8 and 9). The suture line of *H. diadema* as figured by Beyrich (see his fig. 10) shows that the latter has a much narrower lateral lobe than *H. magistrorum*.

Its geographical distribution is wide. It is known from western and eastern Eire, Lancashire, Yorkshire, South Wales, Belgium and Westphalia (text fig. 2).

I have named the species *H. magistrorum* in honour of Mr. W. S. Bisat, F.R.S. and Dr. R. G. S. Hudson, distinguished Carboniferous stratigraphers, who together recognised its distinctive characters.

ACKNOWLEDGEMENTS.

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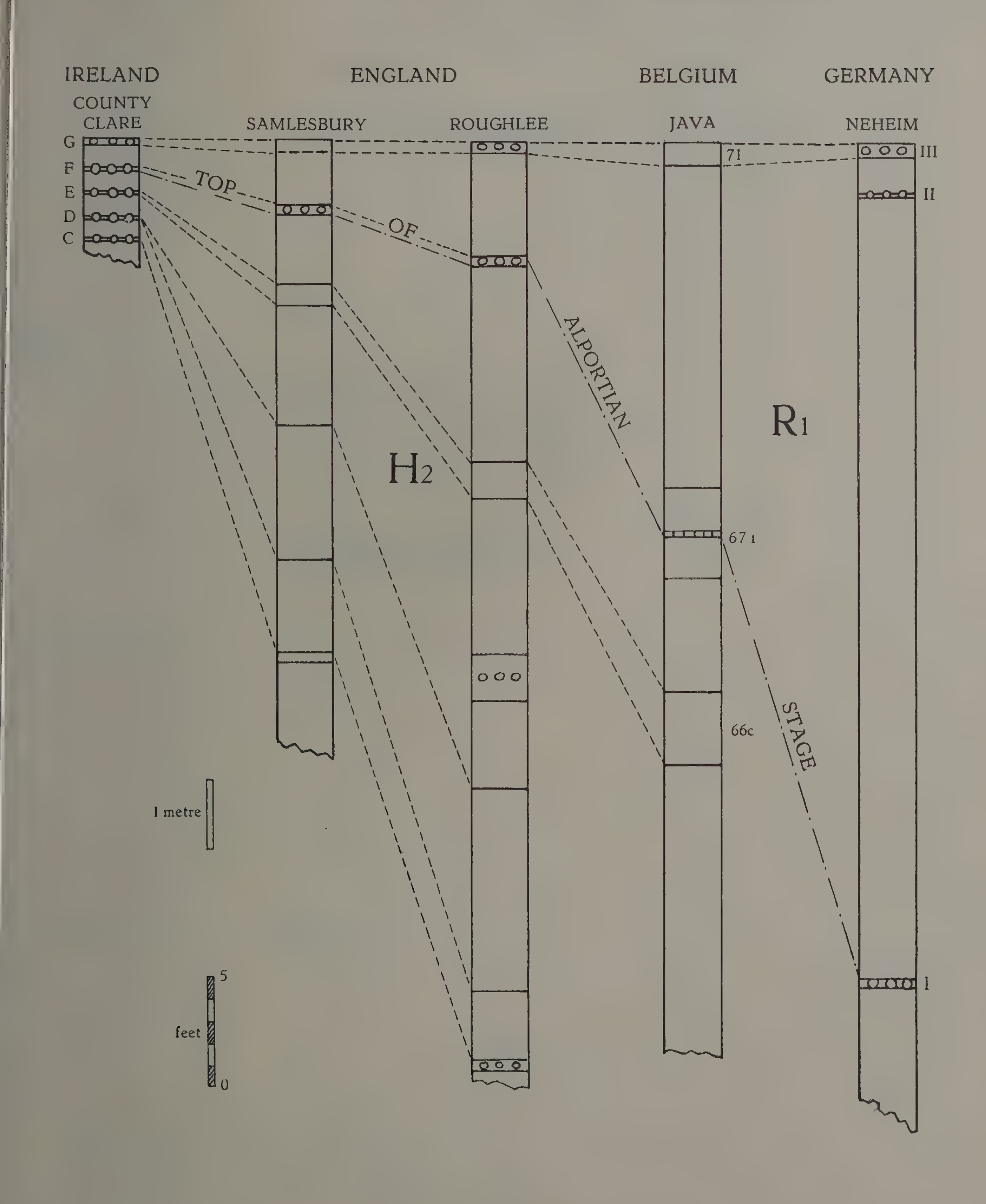
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EXPLANATION OF PLATES I AND II.

PLATE I. — Thicknesses of beds between *H. magistrorum* and *R. circumplicatile* faunal bands from Western Ireland to Westphalia.

PLATE II. — Comparative sections of beds near the junction of the Upper *Homoceras* (H_2) and lower *Reticuloceras* (R_1) stages from Western Ireland to Westphalia.

PLATE I


IRELAND
ENGLAND
BELGIUM
GERMANY
COUNTY CLARE
SAMLESBURY
ROUGHLEE
JAVA
NEHEIM
G
F
E
D
C
TOP OF ALPORTIAN STAGE
H2
R1
71
67 I
66c
III
II
I
1 metre
feet
5
0

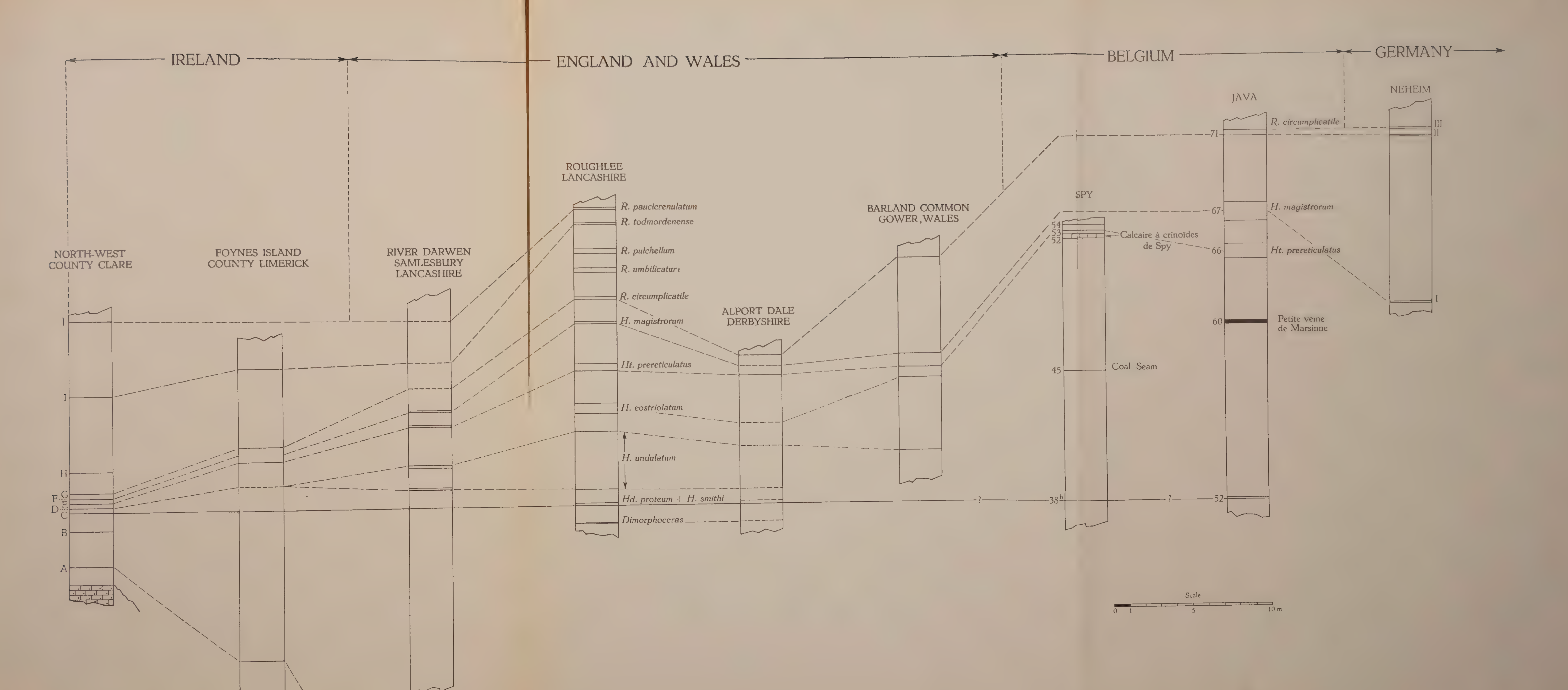

IRELAND
ENGLAND AND WALES
BELGIUM
GERMANY
NORTH-WEST COUNTY CLARE
FOYNES ISLAND COUNTY LIMERICK
RIVER DARWEN SAMLESBURY LANCASHIRE
ROUGHLEE LANCASHIRE
ALPORT DALE DERBYSHIRE
BARLAND COMMON GOWER, WALES
SPY
JAVA
NEHEIM
J
I
H
G
F
E
D
C
B
A
R. paucicrenulatum
R. todmordenense
R. pulchellum
R. umbilicatum
R. circumplicatile
H. magistrorum
Ht. prereticulatus
H. eostriolatum
H. undulatum
Hd. proteum + H. smithi
Dimorphoceras
54
53
52
Calcaire à crinoïdes de Spy
45
Coal Seam
38b
71
67
66
60
52
Petite veine de Marsinne
III
II
I
Scale
0 1 5 10 m

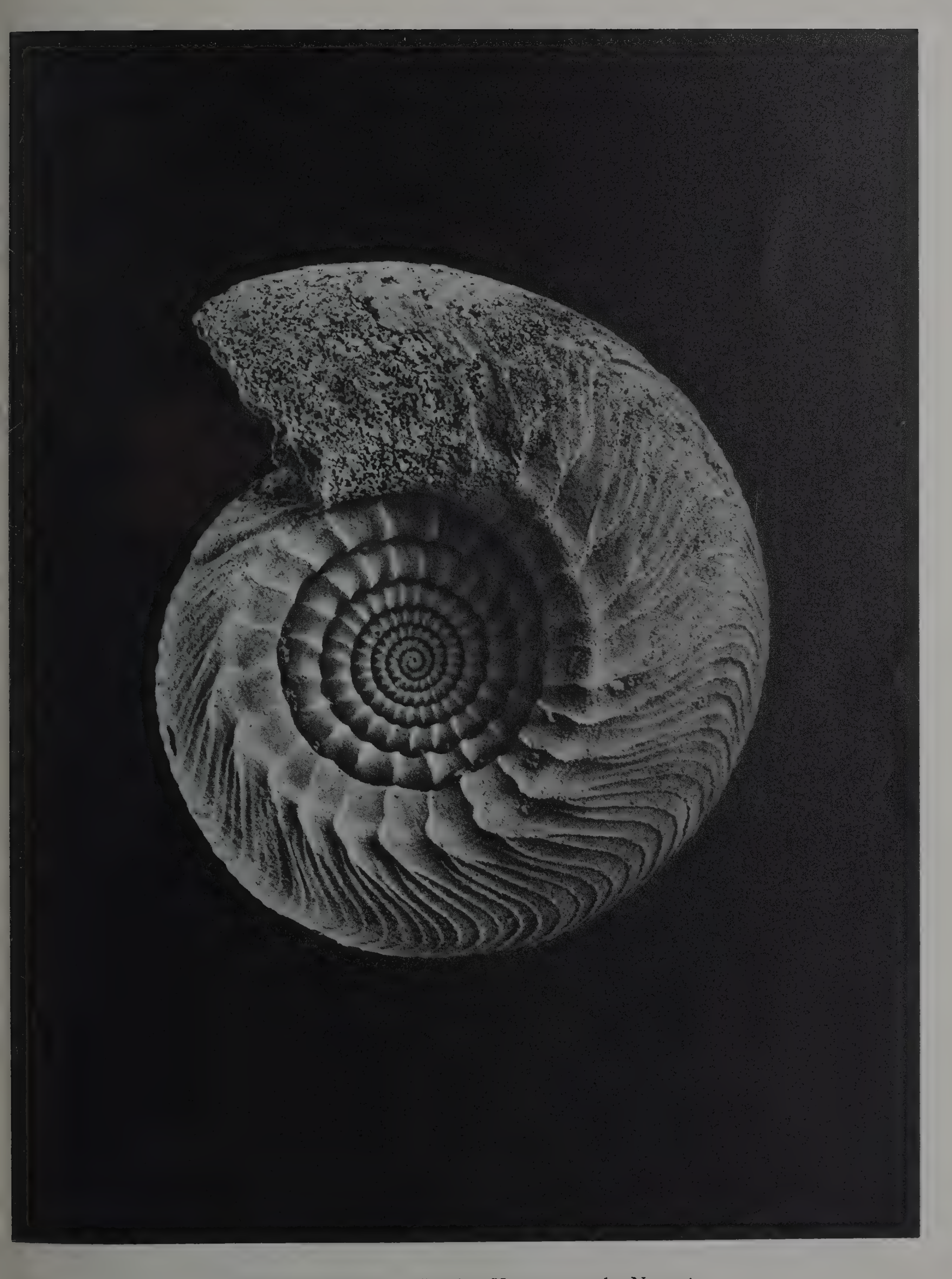
PLATE A

EXPLANATION OF PLATE A.

Reticuloceras circumplicatile (Foord).

R. circumplicatile faunal band. Emde Brickworks Quarry, Neheim, Westphalia, Western Germany.

Geol. Surv. London, No. 86917. × 10.



FRANK HODSON. — Marker Horizons in the Namurian.

Phototypie A. Dohmen, Bruxelles

PLATE B

EXPLANATION OF PLATE B.

Fig. 1. — *Reticuloceras circumplicatile* (Foord).

Kilmoon River, Lisdoonvarna, Co. Clare, Eire. × 8,9.

Fig. 2. — *Reticuloceras circumplicatile* (Foord).

Lectotype. *R. circumplicatile* faunal band. Lisdoonvarna district, Co. Clare, Eire.

Geol. Surv. of Ireland, No. 4803 K. × 5.

Fig. 3. — *Reticuloceras compressum* Bisat and Hudson.

Homoceras magistrorum faunal band. River Aille, Phosphate Mine, Roadford, Co. Clare, Eire.

Geol. Surv. London, No. 86929. × 5.

Fig. 4. — *Reticuloceras circumplicatile* (Foord).

R. circumplicatile faunal band. Pendle Water, Roughlee, near Nelson, Lancashire.

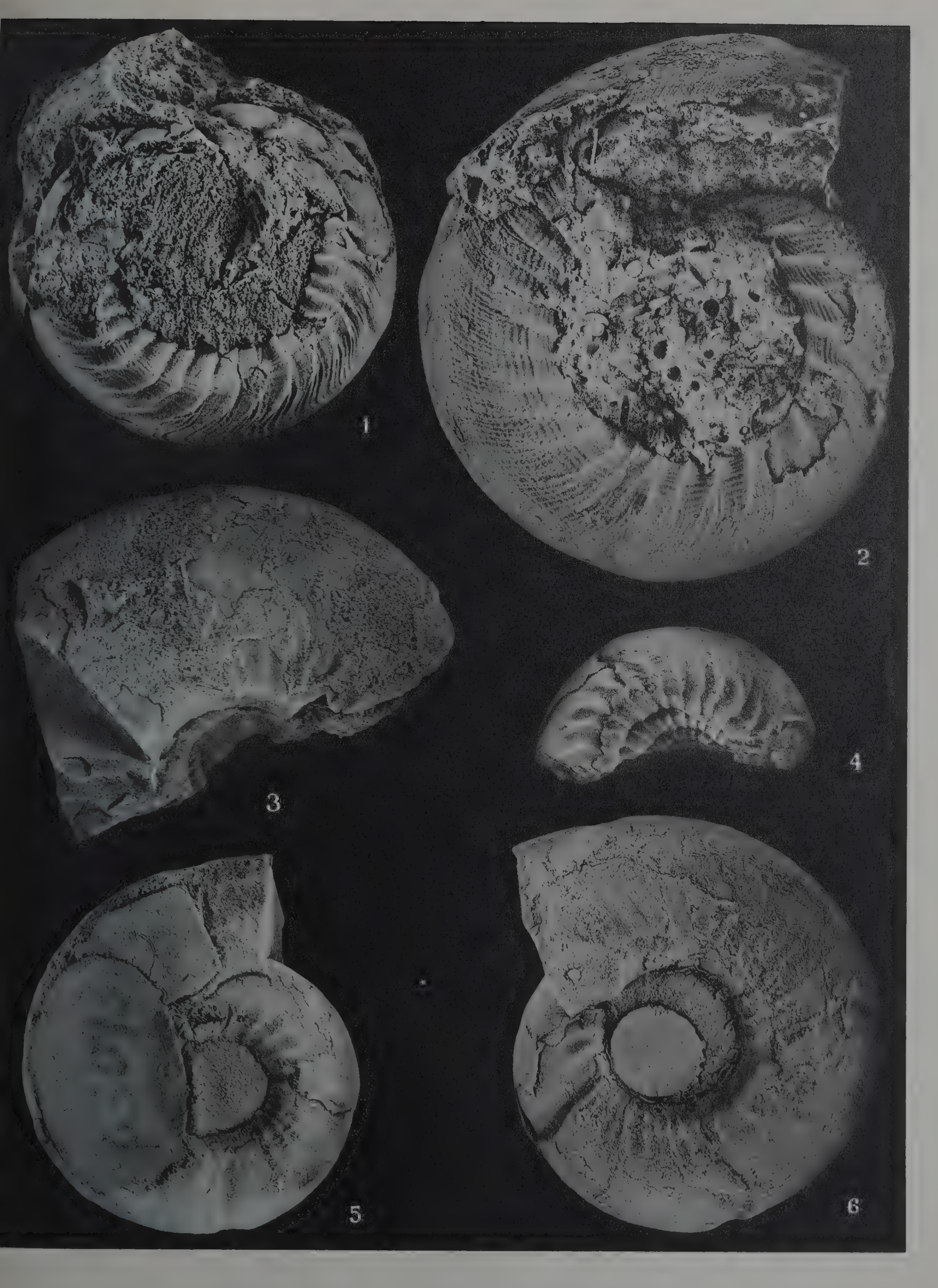
Geol. Surv. London, No. 86938. × 5.

Fig. 5. — *Reticuloceras compressum* Bisat and Hudson.

Holotype. River Darwen, Samlesbury Bottoms, near Blackburn, Lancashire. Not *in situ.*

Geol. Surv. London, No. 63093. × 4,7.

Fig. 6. — Ditto. The same specimen. × 5.



FRANK HODSON. — Marker Horizons in the Namurian.

Phototypie A. Dohmen, Bruxelles

PLATE C

EXPLANATION OF PLATE C.

Fig. 1. — *Homoceras magistrorum* sp. nov.

Holotype. *H. magistrorum* faunal band. River Aille, near Lisdoonvarna, Co. Clare, Eire.

Geol. Surv. London, No. 86909. × 12.

Fig. 2. — *Homoceras henkei* Schmidt.

H. magistrorum faunal band. River Aille, Phosphate Mine, Roadford, Co. Clare, Eire.

Geol. Surv., No. 86931. × 4.



FRANK HODSON. — Marker Horizons in the Namurian.

Phototypie A. Dohmen, Bruxelles

PLATE D

EXPLANATION OF PLATE D.

Fig. 1. — *Homoceras magistrorum* sp. nov.
H. magistrorum faunal band. River Aille, near Lisdoonvarna, Co. Clare, Eire.
Geol. Surv. London, No. 86911. × 4.

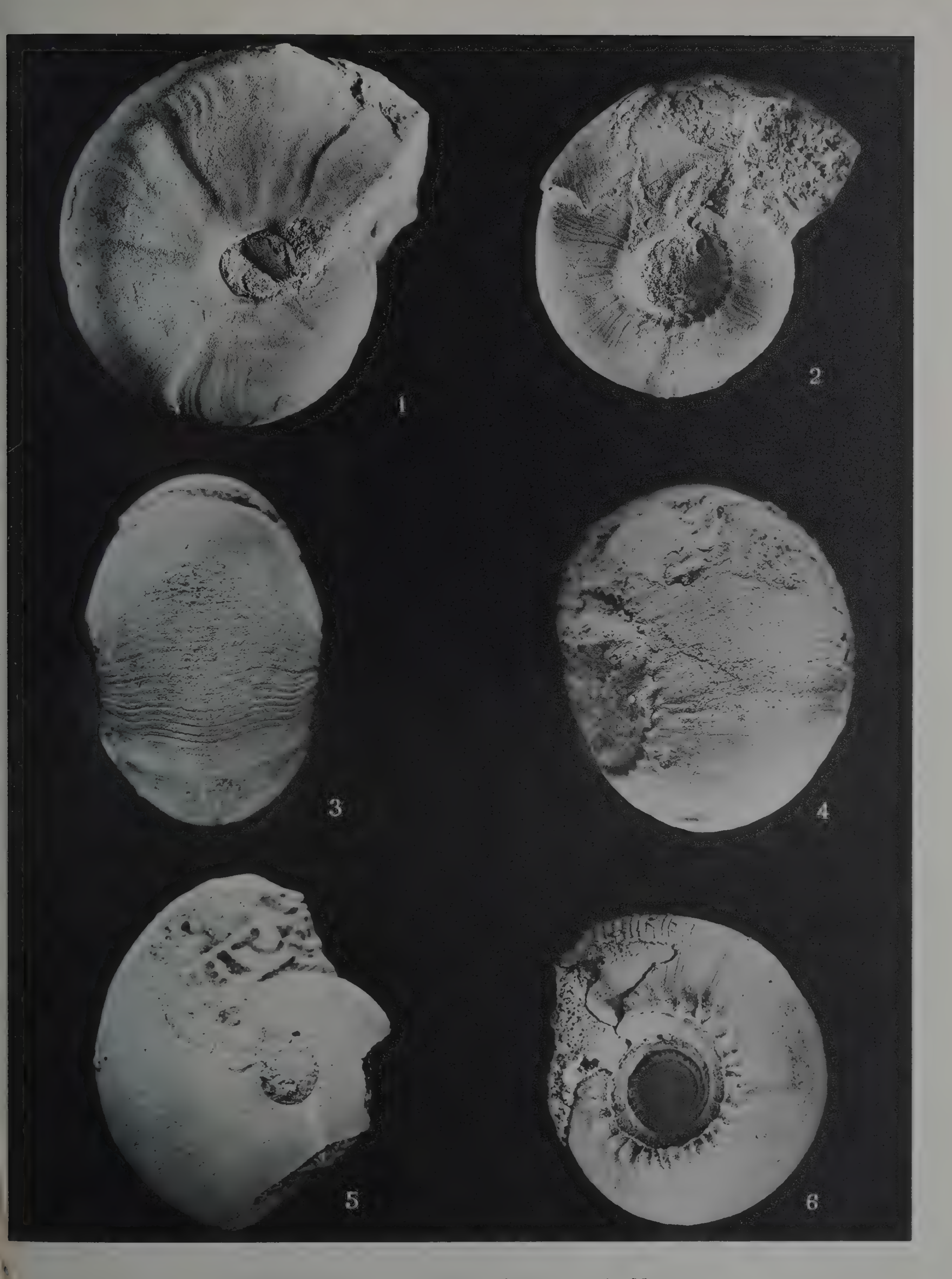
Fig. 2. — *Homoceras magistrorum* sp. nov. Globose form.
H. magistrorum faunal band. River Aille, Phosphate Mine, Roadford, Co. Clare, Eire.
Geol. Surv. London, No. 86912. × 4,5.

Fig. 3. — Ditto. The same specimen. Venter. × 5.

Fig. 4. — Ditto. Another specimen now lost. × 6,2.

Fig. 5. — *Homoceras magistrorum* sp. nov.
H. magistrorum faunal band. River Aille, near Lisdoonvarna, Co. Clare, Eire.
Geol. Surv. London, No. 86910. × 4.

Fig. 6. — *Homoceras magistrorum* sp. nov.
H. magistrorum faunal band. Emde Brickworks Quarry, Neheim, Westphalia, Western Germany.
Geol. Surv. London, No. 86935. × 6,5.



FRANK HODSON. — Marker Horizons in the Namurian.

Phototypie A. Dohmen, Bruxelles

PLATE E

EXPLANATION OF PLATE E.

Fig. 1. — *Homoceratoides varicatus* Schmidt.

R. circumplicatile faunal band. Kilmoon River, Lisdoonvarna, Co. Clare, Eire. Not *in situ*. × 3,5.

Fig. 2. — Ditto. Internal mould of another specimen. × 5.

Fig. 3. — *Homoceratoides varicatus* Schmidt.

R. circumplicatile faunal band. Emde Brickworks Quarry, Neheim, Westphalia, Western Germany.

Geol. Surv. London, No. 86930. × 8.

Fig. 4. — *Homoceras henkei* Schmidt.

H. magistrorum faunal band. River Aille, near Lisdoonvarna, Co. Clare, Eire.

Geol. Surv. London, No. 86934. × 3,5.

Fig. 5. — *Homoceras henkei* Schmidt (young).

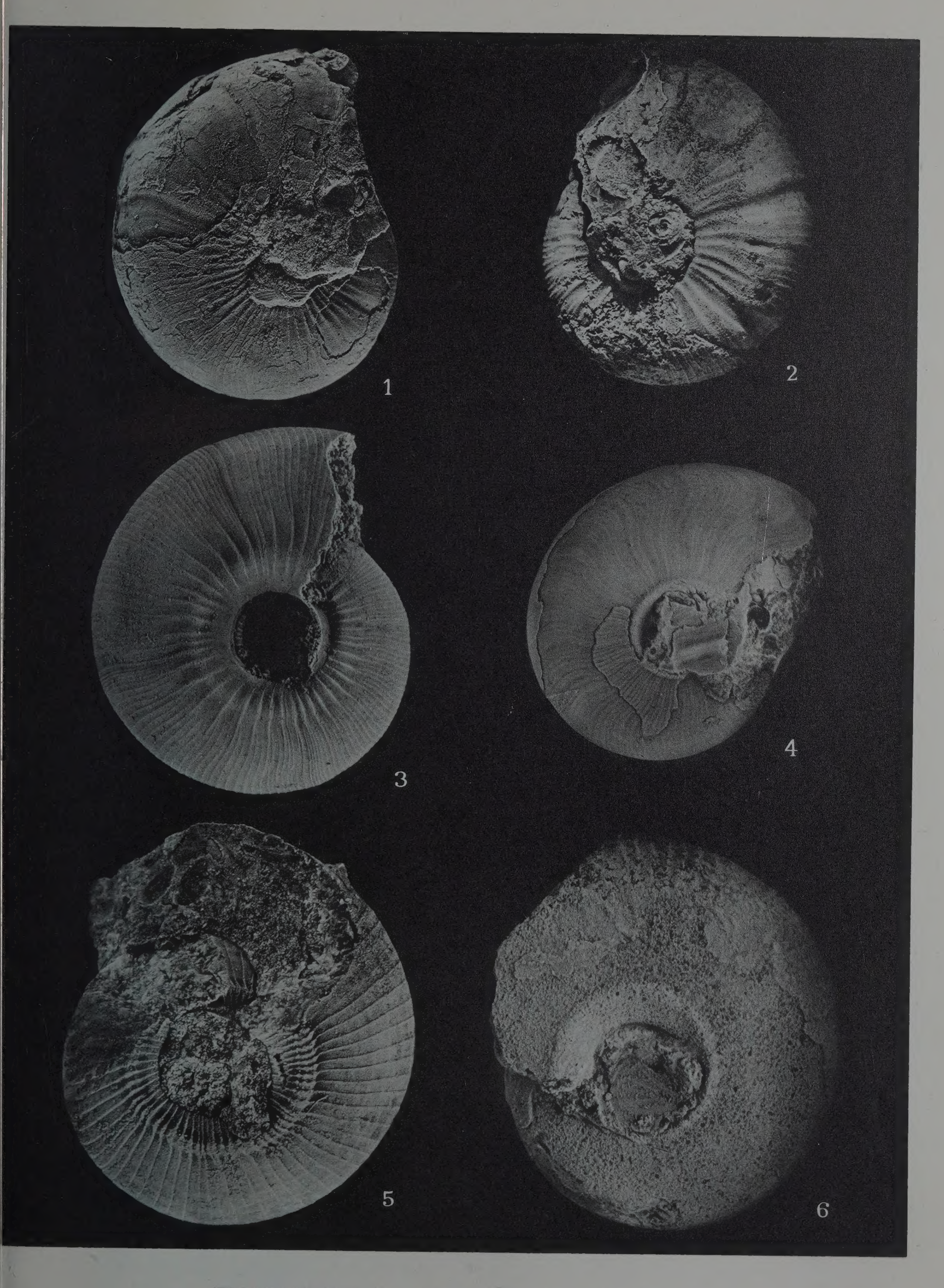
H. magistrorum faunal band. River Aille, near Lisdoonvarna, Co. Clare, Eire.

Geol. Surv. London, No. 89946. × 8.

Fig. 6. — *Homoceras henkei* Schmidt.

H. magistrorum faunal band. Emde Brickworks Quarry, Neheim, Westphalia, Western Germany.

Geol. Surv. London, No. 86936. × 6,8.



FRANK HODSON. — Marker Horizons in the Namurian.

Phototypie A. Dohmen, Bruxelles

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IMPRIMERIE HAYEZ, s.p.r.l.
112, rue de Louvain, 112, Bruxelles
Gérant : M. Hayez, av. de l'Horizon, 39
Woluwe-Saint-Pierre